Carnivorous Plants of New Zealand: A Review

Robert Gibson, P.O. Box 287, PENRITH, N.S.W., 2750, AUSTRALIA

The following is an account of the native carnivorous plant species of New Zealand based entirely upon available literature. Seven species of Drosera and five species of Utricularia occur naturally in New Zealand, and all but two (*D. stenopetala* and *U. delicatula*) are found also in adjacent eastern Australia or New Caledonia. Despite this, many of these species have evolved in isolation into locally endemic forms which may warrant sub-specific status. This account is intended to only be a review of these New Zealand carnivorous plants and, by its very nature, is general and incomplete. I hope that it will reveal the considerable gaps in our knowledge and prompt the publication of supplementary observations from those in New Zealand.

New Zealand is an island nation, in the south-west Pacific, which consists of two main islands - the North Island and South Island, with smaller islands to the north and south, of which the largest is Stewart Island (Fig. 1). Geologically it is a mosaic of fragments of Gondwana which rifted from the eastern margin of Australia 80-60 million years ago (M.A.), and from Marie Byrd Land (Antarctica) 80-65 M.A. Present-day New Zealand represents only a small percentage of this micro continent, most of which is currently below sea-level. The islands lie at the tectonic plate boundary of the Indo-Australian and Pacific Plates, the interaction between them has resulted in the Southern Alps of the South Island, and the active volcanism in the North Island (White, 1990).

The native carnivorous plant species are described below, and their approximate distributions are shown in Figure 2.

D. arcturi

Drosera arcturi is a rhizomatous, sparsely-rosetted winter-deciduous species. Three to six linear leaves are produced from October to February, and grow up to 12 cm long by 1 cm wide, with a short, but indistinct non-glandular petiole. The rhizomes grow to 20 cm long and are mostly buried in the substrate (Hooker, 1853). Growing leaves are folded along their length and grow erect (Gibson, 1992a), which differs from the predominant modes of leaf growth in the genus where the blade is applied to the petiole, or uncurls (Juniper et al. 1989). The scape is produced from late November into December and bears a single, or very rarely two, white-petalled flower(s), which may be pollinated by moths. Plants becomes dormant in early autumn and the summer leaves and scape die. Seed is shed in early autumn and germinates the following spring when the growth recommences (Hooker, 1853; Cotter, 1987).

This species is found throughout alpine and sub alpine areas, to 1500 metres (Burrows, 1986), of the North and South Islands (Fig. 2A), extending to sea-level on Stewart Island (Hooker, 1853). The main habitats are sphagnum bogs, which they dominate, or peat-based bogs where they grow amongst grasses and sedges. It may be found in association with *D. spatulata*, *D. stenopetala* and *U. monanthos*, as at the top of Arthur's Pass, South Island (Boon, 1988). It is also found in Australia, on peaks in the Snowy Mountains, and throughout central and south-west Tasmania (Erickson, 1968).

D. auriculata

Drosera auriculata is the most widespread of the two tuberous Drosera species in New Zealand (Harris, 1988). It commences growth from May, and initially forms a basal rosette, or emerges in mid-winter and forms an erect, or partially trailing, stem immediately which grows to 60 cm tall (Maulder, 1982). Plants often branch in the upper portion of the stems and each terminates in an inflorescence. The flowers have black-dotted, hairless sepals (Salmon, 1991a), and pink, rarely white petals, and are

produced from August to November, prior to the plant becoming dormant (Harris, 1988; Maulder, 1982). In some situations a flowering plant may resprout from its base and extend its growing season (Salmon, 1991a).

Drosera auriculata is found throughout the North Island, especially in the north-west (Rowe, 1986) and in the north of the South Island (Hooker, 1853) (Fig. 2B.). It grows abundantly in moist clay (Jerebine, 1987; Harris, 1988), in the better-drained margins of swamps (Salmon, 1988; Rowe, 1986), and in disturbed areas in woodland (Irving, 1988). It is commonly found with, or near, *D. binata*, *D. peltata*, *D. pygmaea*, *D. spatulata*, *U. delicatula* and *U. novae-zelandiae* (Anon., 1987; Rowe, 1986). This species is also found in south-eastern Australia and Tasmania (Erickson, 1968).

D. binata

Drosera binata is a distinctive, rosetted perennial with erect, petiolate dichotomously branched filiform lamina, which may branch further. One to three scapes are produced between late Spring and late Summer. They typically grow 30 to 40 cm tall, and have white-petalled flowers to 1.5 cm diameter (Salmon, 1991a). Plants are dormant from March to July (Maulder, 1982).

The leaves vary in height from 10 cm to over 100 cm, and the lamina may have two to twenty lobes, and spread over 30 cm. The tallest plants grow amongst dense herbage and produce significantly shorter leaves in open ground (Maulder, 1984a). Up to three variants may occur in New Zealand, based tentatively on leaf division alone. *Drosera binata* "t-form" has been recorded from Northland (Rowe, 1986), but is probably subordinate to *D. binata* var *"dichotoma"* which has two to four lobes per leaf. *Drosera binata* var. *multifida*, with evenly divided leaves with up to 14 lobes, has potentially been found in single swamp (Maulder, 1984a).

Drosera binata is widespread in New Zealand (Fig. 2C.) and is found in the North, South, Stewart and Chatham Islands (44 00'S, 176 40'W) (Hooker, 1853), and also occurs in eastern Australia (Erickson, 1968). It grows on clay banks, in swamps, creek beds and on wet rock faces, usually in a sunny location (Maulder, 1984a). Plants may even be found growing under a few centimetres of water in the wettest parts of swamps and the margins of lakes (Salmon, 1991a). It is often found with, or near, *D. auriculata*, *D. pygmaea*, *D. spatulata*, *U. delicatula* and *U. novae-zelandiae* (Salmon, 1991a; Anon. 1987; Rowe, 1986). This species appears the most resilient to polluted water and weeds and remains on degrading sites longer than other native carnivorous plants (Salmon, 1991).

D. peltata

Tuberous *D. peltata* has only recently been discovered in New Zealand, and is potentially a recent arrival from Australia. To date it has been found in a limited distribution in the far north of the North Island, north of Auckland (Fig. 2B.). Plants are golden green in colour, usually form a basal rosette, grow to approximately 20 cm tall, have very few branches which terminate in inflorescences. The flowers have pink petals, hairy sepals, and the globular fruits produce small round seed. They produce daughter tubers, which apparently *D. auriculata* does not (Maulder 1991; Salmon, 1991a). No details of the growing season have been published but plants probably commence above ground growth in March, stem growth in July and flower from August to October. This species often grows with *D. auriculata* and *D. pygmaea* in grassland (Maulder, 1991; Salmon, 1991a).

This species also occurs in south-eastern Australia, Tasmania, part of south-west Western Australia, and throughout South East Asia to Japan and India, and possibly in Central Africa (Erickson, 1968; Lowrie, 1987; Clarke, 1879; Degreef, 1991). The New Zealand plants strongly resemble the green-rosetted, pink-petalled variety found in eastern New South Wales (Gibson, 1992b).

D. pygmaea

Drosera pygmaea is the smallest sundew native to New Zealand with rosettes

around 1 cm diameter (Salmon, 1991a). Two variants have been found, the most common has dark red leaves and scapes, and an all-green form has been found in the centre of the North Island, but its taxonomic status has not yet been determined (Maulder, 1991). The species has a prominent silvery-white stipule bud, which protects the growing point from desiccation and damage. Single flowered scapes are produced over the summer, and gemmae are probably produced in late autumn to mid-winter, although the exact details of these have yet to be published.

This species has only been reported from the North Island (Hooker, 1853) (Fig. 2D.), particularly north of Auckland (Salmon, 1991a; Anon, 1987; Rowe, 1986). It is often found growing with, or near, *D. auriculata*, *D. binata*, *D. peltata*, *D. spatulata*, and *U. novae-zelandiae*, in a range of habitats, all at low altitude, including grassland, swamps and lake edges (Salmon, 1991a; Anon, 1987; Rowe, 1986). Drosera pygmaea is also found across the Tasman sea in eastern and south-eastern Autsralia, Tasmania and south-west western Australia (Lowrie, 1989).

D. spatulata

Drosera spatulata is a widespread perennial, spathulate-leaved species which occurs throughout New Zealand (Fig. 2D.). Two distinct forms occur. The most common is the "New Zealand Form" (Slack, 1980), which grows to 4 cm diameter. The leaves have a distinctive narrow, straight-sided petiole to 8 mm long, which lacks retentive glands on the basal half. The lamina are 5 mm long by 4 mm wide. During winter these plants go dormant in cold habitats. Scapes, to 8 cm tall, are produced from early summer, and on average bear 6 flowers each in a one-sided raceme. The inconspicuous white-petalled flowers are up to 6mm diameter (Salmon, 1991a).

An unusual form, with potential subspecies status, has been found between Turangi and Waioru along the Desert Road, in the centre of the North Island, by Bruce Salmon (1988). The few-leaved, vivid red rosettes, to 1cm diameter, grow in small colonies in damp peat and clay soil. It over-winters as a dormant bud between June and September, and produces a scape to only 1cm tall. In cultivation, in warmer Auckland, this form grows to 2.5 cm diameter and is still winter-dormant. This form may be identical to variety "pusilla", from Lake Taupo and the foot of Tongariro, which is described only as "scapis 1-3 floris, sepalis latioribus" (Hooker, 1853, page 20). It is not said whether the plants are deciduous or evergreen.

The typical form of *Drosera spatulata* in new Zealand is found throughout the North, South and Stewart Islands (Hooker, 1853; Wilson, 1978), in sunny, permanently wet locations from coastal swamps to alpine sphagnum swamps, to approximately 1250 metres elevation (Burrows, 1986). *Drosera spatulata* is also found in eastern Australia, and South East Asia, as far north as Japan (Erickson, 1968). A number of distinct forms occur throughout its range (Slack, 1980). Genetic studies of some populations has yield data which suggests that this species evolved in New Zealand, and then spread west and north (Degreef, 1989). It is not yet certain when this migration began, before or after New Zealand became separated from Gondwana approximately 65 M.A. (White, 1990), which would have profound implications on the age of this species.

D. stenopetala

Drosera stenopetala is a perennial, winter-deciduous species endemic to New Zealand. It forms a rosette of up to 10, or more, spathulate leaves from spring to early autumn, which arise from a short underground rhizome (Hooker, 1853). The leaves are up to 10 cm long, with a glabrous petiole to ca. 80 mm long by ca. 4 mm wide, surmounted by an ovate lamina to 15 mm long by 6 mm wide. A single-flowered scape rises above the rosette and isopen between December and February. The white-petalled flower has a large ovary surmounted by three deeply-divided styles (Birmingham, 1983; Hooker, 1853). This species forms a dormant bud in early Autumn, the nature of which has yet to be described in the literature, and will be a function of the

nature of growth habit of the leaves.

Drosera stenopetala is found in the North, South, Stewart, Auckland (50 40'S, 166 05'E) and Campbell (52 30'S, 169 00'E) Islands (Diels, 1906) (Fig. 2A.). In the latter two localities a few small plants have been found on Campbell Island (Laing, 1909), but it is quite common in lowland bogs in the Auckland Islands (Johnson and Campbell, 1975), where the generally small plants have initially been difficult to identify, and bear a strong resemblance to the closely related D. uniflora (Hooker, 1847 and 1853). In general this species grows in montane and sub alpine areas, in tarns, swampy areas and occasionally on wet rock faces, which all have constantly flowing water. It has a preference for shaded swampy areas, and is often found with D. arcturi, but never with *D. spatulata* (Birmingham, 1983).

This species extends to higher altitudes (to 1800 metres (Burrows, 1986)), and latitudes than *D. arcturi*, and therefore appears to be more cold-tolerant. Its presence on Auckland and Campbell Islands may reflect the longevity of this species. I speculate that it grew on the emergent Campbell Plateau prior to its almost complete submergence in the Eocene Epoch (57.8-36.6 M.A.) (White, 1990). It is part of a diverse flora, which is now limited to the highest, currently emergent, parts of it. The relatively large pyriform seeds do not appear conducive to wind transport.

Drosera stenopetala is one of the three species (with *D. arcturi* and *D. uniflora*) which comprise section Psyochila (Diels, 1906) which is restricted to cold temperate areas of Australia, New Zealand and South America. All three species display many characters which are regarded as primitive, and also show a Gondwanan distribution. This is supported by the discovery of fossilized pollen of *Drosera arcturi*, and its ancestor "Dreridites tholus", in early Eocene sedimentary rocks in Tasmania (Macphail, 1988).

Utricularia australis

Utricularia australis is a robust aquatic bladderwort of variable stature, which is generally shy to flower. The variability has led to this species being described as endemic species, *U. protrusa* and *U. mairii* (Taylor, 1989). The basely-bifurcated much-divided leaves grow to 6 cm long, with green to black bladders to 4 mm long. The stem segments grow to over 4 metres long, but are often shorter, and float at, or up to 1 metre below, the water surface (Maulder, 1984b). Scapes develope from December to March, which may develop en-masse in particular lakes, and can develop floats (Maulder, 1984b). One to three scapes are produced per plant, which have up to eight, small, completely yellow flowers each (Maulder, 1985c) which may be aborted at any stage of their growth (Maulder, 1984b). The species forms turions in response to desiccation and unfavourably cold (winter) temperatures (Maulder, 1984b; Taylor, 1989).

Despite the abundance of lakes and streams in New Zealand, *U. australis* is an uncommon species. It has been found in the northern half of the North Island and has been record from one location on the west coast of the South Island (Moar and Mason, 1976) (Fig. 2E.). Perhaps the raised mineral concentrations in many lakes and rivers in the North Island, due to geothermal activity, makes many otherwise suitable habitats toxic to this species? At present the species most commonly found in lakes north of Auckland (Salmon, 1991a; Rowe, 1986; Maulder, 1985c; Maulder, 1984b), and sometimes grows with U. gibba (Maulder, 1984b). Utricularia australis also occurs in Australia, tropical and temperate Asia, tropical and temperate Africa, and Europe (Taylor, 1989).

U. delicatula

Utricularia delicatula is endemic to New Zealand, and is very similar to *U. lateriflora* from south-eastern Australia (Taylor, 1989), and has been confused with it in the past (Boon, 1990; Salmon, 1991a). It is a small, terrestrial Utricularia with small, bright green spathulate leaves to 10 mm long, by 1mm wide (Salmon, 1991a)

which are easily overlooked. The slender purple scapes, to 10 cm tall, have one to four alternately arranged tiny flowers, which are produced from mid-November (Rowe, 1986), to February (Taylor, 1989). The flowers are white, rarely with a subtle blue tinge on the lower lip (Salmon, 1991a). This species is confined to the northern half of the North Island, especially in the far north (Salmon, 1991a; Rowe, 1986) (Fig. 2F.).

U. gibba

Utricularia gibba is the other species of aquatic bladderwort in New Zealand, about which little has been written. This generally small species flowers prolifically from January to March (Maulder, 1984b). It has been recorded at Bethell's Swamp, north-west of Auckland as *U. biflora*, and considered an introduced water weed (Boon, 1990). However, this species also occurs in eastern Australia and New Caledonia which open up the possibility for natural introduction by migratory water birds. This view may be supported by the fact that this wide-ranging species is also found in temperate and tropical Africa and the Americas, as well as western Europe, the eastern Mediterranean shore, and South East Asia (Taylor, 1989).

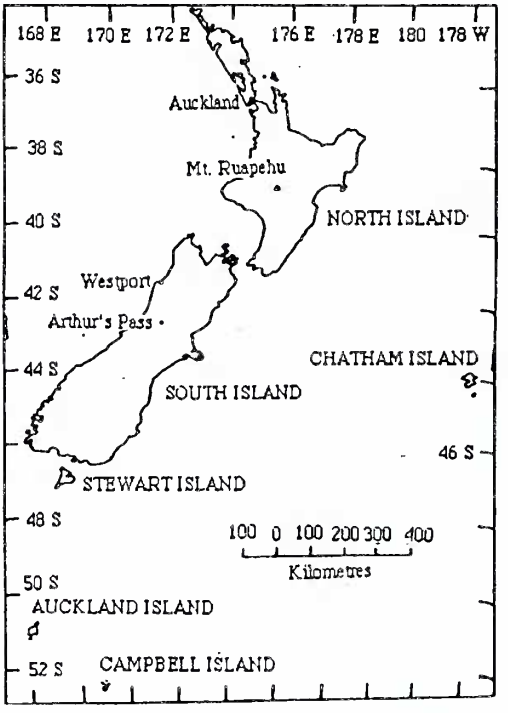

Figure 1: Location Map of New Zealand and the nearby Auckland, Campbell and Chatham Islands.

U. monanthos

Utricularia monanthos is widespread in New Zealand (Fig. 2F.), especially in the South Island, and occurs also in Stewart Island (Wilson, 1987), the most southerly location for the genus (Taylor, 1989). It grows in wet areas, mainly in higher altitudes, but occurs at sea-level at the southern end of its range. The summer-produced, predominantly single-flowered scapes grow from 3 to 10 cm tall, and support a lavender purple flower, to 7mm across, with a yellow ridges on the palate, which are large in comparison to the sometimes winter-deciduous leaves (Salmon, 1991b; Maulder, 1985a; Jenks, 1983). This species is variable in stature, which has caused some taxonomic confusion with the very similar *U. dichotoma* (Taylor, 1989). The latter species does not occur in New Zealand, and unconfirmed reports of it at Westport, South Island (Salmon, 1990), may be robust *U. monanthos* plants.

This species also occurs in Australia, where it is found in alpine, and sub-alpine areas of the Snowy Mountains, and throughout the central plateau of Tasmania (Erickson, 1968).

U. novae-zelandiae

Utricularia novae-zelandiae is found throughout the North Island (Fig. 2F.) and less-commonly, in all but the south-west portion of the South Island, and also occurs in New Caledonia. The endemic *U. colensoi*, *U. subsimils*, *U. vulcania* and *U. sp. "Lake Ohia"*, from the North Island have been reduced to synonymy (Taylor, 1989; Maulder, 1985b). It is close to *U. monanthos*, but differs primarily in flower colour, palate

structure and the distinctly upturned edge of the lower lip. The dark purple scapes are produced from November (Maulder, 1985b), to February (Taylor, 1989), and support 1 or 2 white flowers to 8 mm across. The ridges of the palate are yellow, edged red, and red veins occur in the upper lip (Salmon, 1991b).

This species has been recorded close to sea-level in the northern tip of New Zealand (Rowe, 1986), as well as at an unspecified altitude on Mount Ruapehu, in the centre of the North Island, where it may hybridize with *U. monanthos* (Salmon, 1991b).

The conservation status of the native carnivorous plants of New Zealand is mixed. The widespread species-*D. arcturi*, *D. auriculata*, *D. binata*, *D. pygmaea*, *D. spatulata*, *D. stenopetala*, *U. novae-zelandiae* and *U. monanthos* are not threatened. However, the less-widespread *D. peltata*, *U. australis*, *U. delicatula* and *U. gibba*, which are primarily found in the northern half of the North Island have a less-secure future. Farming activities, including draining swamps, and the application and runoff of fertilizers, as well as some recreational watersports have already depleted or destroyed historically good carnivorous plant sites (Salmon, 1991a; Rowe, 1986; Maulder, 1985a).

All native species occur in the North Island, with the highest concentration in the far north. With the possible exception of *D. auriculata*, which can reverse its growing and dormant seasons, those species on the South Island are summer-growing and winter dormant/ deciduous. This distribution may reflect the extensive Quaternary glaciation of the South Island, and voluminous explosive volcanism in the centre of the North Island (White, 1990).

The carnivorous plants of New Zealand show strong overlap with those species found in eastern Australia, which probably reflects migration across the Tasman Sea, and the possibility that some species predated the breakup of Australia, Antarctica and New Zealand. Several species have begun to evolve in isolation into distinctive New Zealand forms, which includes two endemic species (*D. stenopetala* and *U. delicatula*). It is hoped that this review has painted a general picture of the native carnivorous plants of New Zealand, and that it will generate the publication of additional information from those with the means to observe these plants in the wild.

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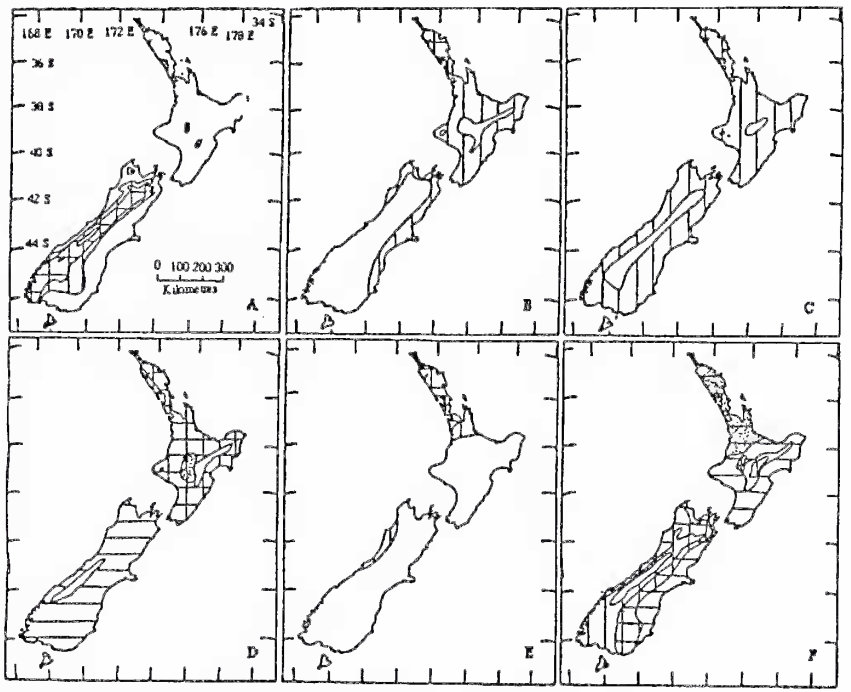

Figure 2: Approximate distribution maps of the native New Zealand carnivorous plants: **(A)** *Drosera arcturi* (vertical stripes) and *D. stenopetala* (horizontal stripes); **(B)** *D. auriculata* (vertical stripes) and *D. peltata* (horizontal stripes); **(C)** *D. binata* (vertical stripes); **(D)** *D. pygmaea* (vertical stripes), *D. spatulata* (horizontal stripes) and *D. spatulata* var. *pusilla* (stippled); **(E)** *U. australis* (vertical stripes) and *U. gibba* (horizontal stripes); and **(F)** *U. delicatula* (stippled), *U. monanthos* (vertical stripes) and *U. novae-zelandiae* (horizontal stripes). Note that *D. binata* also occurs on Chatham Island and *D. stenopetala* also occurs in the Auckland and Campbell Islands, shown in Figure 1.